APPENDIX B

SELECTION OF A LEAD SOIL CLEAN-UP LEVEL FOR THE NL/TARACORP SUPERFUND SITE

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Several sets of comments to the Proposed Plan at the NL/Taracorp site have questioned U.S. EPA's decision regarding the selection of the lead in soil clean-up standards to be used at the site. This document is intended to respond to these comments by setting forth U.S. EPA rationale supporting this decision.

Lead poisoning in young children is one of the most prevalent and preventable childhood public health problems in the U.S. today (USDHHS, 1985). The Environmental Protection Agency's concern with the health hazards of lead is longstanding - The Clean Air Act of 1970 authorized the EPA to set National Ambient Air Quality Standards (NAAQS) for the regulation of air emissions of pollutants considered harmful to public health or welfare; lead was one of the six pollutants to be regulated. In 1974 under the regulatory requirements of the Safe Drinking Water Act, EPA Office of Drinking Water issued its National Interim Primary Drinking Water Regulations; again lead was one of the 26 contaminants addressed. Since 1975, EPA has increasingly restricted automobile emissions; all new cars since 1975 have been equipped with catalytic converters. Because lead destroys the effectiveness of these converters, the use of unleaded gasoline has increased dramatically, with corresponding decreases in lead emissions from exhaust. EPA has moved to accelerate this progress by phasing out lead in gasoline during the 1980s.

Further reductions in the National Ambient Air Quality Standard for lead and the Maximun Concentration Level for lead in drinking water are expected in 1990. The overall effect of these control programs has been a major reduction in the amount of lead being released to the environment.

Lead released into the environment in the past from stationary sources such as factories, power plants and smelters and from mobile sources such as automobiles, buses and other forms of transportation remains a persistent problem. Deposition and precipitation have resulted in the accumulation of high concentrations of lead in the soil in areas where significant releases to the air have occurred. Thus, lead-contaminated soils and housedust have emerged as important contributors to blood lead concentrations in the general population.

The present action has provided a mechanism for the clean-up of the lead in the soil at the NL/Taracorp Superfund site in Granite City. A risk assessment has been prepared by O'Brien & Gere as part of the Remedial Investigation for the NL/Taracorp Superfund site (Remedial Investigation Report 1988). This health risk assessment has correctly identified children as the most sensitive subpopulation, noting that they are at particular risk to lead poisoning due to their greater lead absorption efficiency than adults and to their greater probability of exposure to environmental lead in soil through outdoor play activities, mouthing habits and through intentional ingestion of soil (pica). It further identifies two pathways for lead exposure to the resident population stemming from the Superfund site as being complete: " 1) the airborne route, with lead-bearing soil particulates and dusts transported from friable soils on the Taracorp site to offsite locations for subsequent inhalation, and 2) the direct contact route, with exposed soils previously contaminated with lead from particulate fallout from smelting emissions in previous years providing a source for ingestion of lead residues". Pathways have been identified as complete based on contaminant existence, magnitude, environmental fate, toxicological impacts of components released from the site and transport to receptors. The assessment also acknowledges that "lead in its various environmental forms is able to combine with a variety of physiologically significant proteins in the body, with resultant effects on structure and function".

Because children are developing, they absorb and retain more lead than adults. Thus, even at very low levels of lead exposure, children can experience reduced I.Q. levels, impaired learning and language skills, loss of hearing, and reduced attention spans and poor classroom performance. At higher levels, lead can damage their brains and central nervous systems, interferring with both learning and physical growth. Needleman (1988) has provided a review of 110 publications documenting the health effects of lead in children. He summarized that at low blood lead levels, neurocognitive effects of lead expressed as diminished psychometric intelligence, attention deficits, conduct problems, alterations in the electroencephalogram, school failure and increased referral rates for special needs predominant. He emphasizes that careful epidemiologic studies, which have controlled for the important confounders, have set the level for these effects at 10-15 micrograms per deciliter lead in blood. Exposure to lead in men can cause increases in blood pressure. These health effects and their associated blood lead levels have been summarized by EPA and the Agency for Toxic Substances and Disease Registry (ATSDR), and are summarized in Table 1. Particularly notable are the risks of lead to women of child-bearing age. They include fertility problems and miscarriages. In pregnant women, lead can cause impaired development of the fetus, premature births and reduced birth weights. The data in Table 2 shows that miscarriages and reproductive effects, such as premature birth and low birth weight, may occur at blood lead levels as low as 10 micrograms per deciliters and possibly lower. It is this growing preponderance of literature that has prompted the National Centers for Disease Control (CDC) to consider the lowering of the blood lead level from 25 to 15 micrograms per deciliter to protect for the health effects seen at lower levels. It is also this same growing accumulation of evidence that has led EPA to reject the suggestion put forth by the contractors for NL Industries in their risk assessment that the proposed 15 micrograms per deciliter blood lead level can be considered as a threshold level for the adverse health effects of lead in children. This lack of ability to identify a thresold level for lead coupled with the understanding that Reference Dose (RfD) methodologies are basically route-specific and do not incorporate site-specific information has led EPA to withdraw the RfD for lead. The EPA Environmental Criteria and Assessment Office (ECAO) has suggested instead the use of an uptake/biokinetic modeling approach to develop health critera for lead (U.S.EPA 1989b).

Many considerations have gone into the documentation of a lead soil clean-up level for the NL/Taracorp Superfund site. The first was the inability to find a suitable basis on which to perform a risk assessment based on dose-response relationships given the withdrawal of the RfD for lead. The second was the EPA Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive # 9355.4-02, 1989). This directive sets forth an interim soil clean-up guideline for total lead in soil at 500 to

1,000 ppm. However, it also allows that "site-specific conditions may warrant the use of soil clean-up levels below 500 ppm or somewhat above the 1000 ppm level". This latter guidance was used to evaluate the conditions at the NL/Taracorp Superfund site.

A number of factors have influenced the setting of a lead soil clean-up level for the NL/Taracorp site.

1) The soil at the NL/Taracorp (Granite City) site has been documented as containing elevated levels of lead (Remedial Investigation Report 1988).

2) Smelter operations are known to result in the emission of small aerosol particles which stay airborne and travel over an extensive area (Steele 1989). Because the lead deposits at the NL site originated from air emissions from smeltring operations, the resulting discharge was as fine particles having a wide area of distribution and deposition. (This area has not been fully delineated and further soil testing will be needed to determine the extent of the area contaminated by lead emissions from the NL Industries operations.)

3) The small particles deposited in the soil can cling to skin, clothing and children's toys and can be transferred into the indoor environment as windborne dust or carried in on the shoes or clothing of residents or the fur of household pets.

4) The small lead particles have high bioavailability, due to their easy dissolution in the stomach and the chemical form of the lead salts.

5) Even low exposures to lead have been shown to have significant health effects on developing children, especially those under the age of six years.

6) Children who show tendencies toward frequent mouthing activities can ingest large amounts of soil and indoor dust and hence, large amounts of lead

(Calabrese 1989, Binder 1986). Those who are nutritionally compromised and/or exhibit pica might be at risk for severe health effects.

7) The area of Granite City most affected by the smelter emissions is highly residential and contains a significant number of young children - the subpopulation known to be the most sensitive to the toxic effects of lead.

8) Granite City and the surrounding area is highly industrialized and residents are likely to be exposed to a complex mixture of toxic substances in the air and in the soil, which may act to increase the toxic effects of lead in a synergistic manner. The assessment of health risks from chemical mixtures is of growing concern to EPA (FR 50 1985).

These factors indicate that there is a high possibility of adverse health effects in young children living in the Granite City areas impacted by the NL/Taracorp Superfund site. Accordingly, a soil lead clean-up level of 500 ppm was deemed necessary if this subpopulation is to be fully protected.

This lead soil clean-up level is consistent with the approach being taken for similiar contaminated sites in other countries, other Regions in the U.S, and is advocated by researchers examining lead toxicity in pediatric populations. In a report to the Ontario Minister of the Environment by their Lead in Soil Committee, the committee responded to the request that they review the available literature on lead in soil and recommend "scientifically defensible" soil removal guidelines for lead-contaminated soil (OLSC Report 1987). The committee recommended that a 1000 ppm guideline level is appropriate for areas to which children do not have routine access, while a guideline level between 500 and 1000 ppm is appropriate for areas to which children do have routine access. The comments of the Royal Society of Canada were also included in the report. They recommended that for clean-up around lead-processing or lead-using plants, soil lead levels of up to 500 micrograms per deciliter are acceptable for residential areas and for garden and allotments, while levels of up to 1000 ppm should be acceptable for parklands and other areas to which children have only intermittent access. Similiar conclusions have been reached in the U.S. regarding the soil clean-up at lead smelter sites; lead soil clean-up levels in such impacted residential areas in Regions I, II and VIII have recently been set at 200 t 500 ppm. These are also the conclusions being echoed by researchers in the field. Milar and Mushak (1982) warned that a definite health hazard exists to children when household dust levels exceed either 1000 ppm or 50 micrograms per square meter. Mielke et al. (1989) summarized the work of a number of researchers addressing the question of the safe lead concentration in soil to protect children from undue exposure with the conclusion that a rapid rise in population blood lead levels takes place when the lead content of soil increases from less than 100 ppm to 500-600 ppm. Dr. Mielke has stated in a personal communication that he believes the safe lead soil level in areas contaminated with fine lead particles to be between 200 qnd 250 ppm. A study by Shellshear et al. (1975) in New Zealand concluded that children exposed to more than 100 ppm lead in soil and who also exhibit pica are at major risk to lead exposure.

The site-specific conditions presented earlier led Region V to consider the use of a modeling approach to further evaluate the lead soil clean-up level proposed for this site. This approach is consistent with the recent comments received from NL Industries that the incorporation of the Biokinetic Model and other generic and site-specific data into the development of clean-up levels for lead are appropriate (NL Industries comment to the public response, Exhibit A). The letter from Dr. Krablin, Manager for Environmental Projects, ARCO, included in Exhibit A defends the EPA Integrated Uptake/Biokinetic Model as having been "demonstrated to be a reliable analytical method to determine the relationship between environmental lead concentrations and blood lead concentrations for EPA lead rulemaking". The EPA Office of Research and Development has examined several other modeling approaches, including a lead soil matrix model proposed by the Society for Environmental Geochemistry and Health (SEGH) Task Force on Lead in Soil, and has indicated that the favored approach is the Biokinetic Model. Two recent technical support documents have been issued which present the rationale for this modeling approach for developing health criteria for lead (USEPA 1989b, USEPA 1989c). The Biokinetic Model provides a means for incorporating either site-specific or internationally consistent default assumption values regarding exposure scenarios and absorption efficiencies for lead uptake from various media into the exposure analysis to yield estimates of the relative contributions of air, dietary and soil lead to the total estimated lead uptake.

When site-specific data collected in Granite City and soil lead/dust lead levels of 500 ppm and 1,000 ppm were input into the Lead Uptake/Biokinetic Model, the graphs presented in Figures 1 and 2 were obtained. Figure 1 uses the 500 ppm soil lead/dust lead level, soil ingestion rates of 0.100 grams per day as suggested by O'Brien & Gere rather than the default Calabrese data, air lead levels taken from the Remedial Investigation Report, and default values as listed from the Users Guide for Lead: A PC Software Application of the Uptake/Biokinetic Model. No pica was considered; lead in paint was considered not to be available for ingestion (painted surfaces in good condition). An U.S. average water lead level was included to account for the contribution from lead in plumbing. The model predicted the mean blood lead level for children under the age of six to be 8.37 micrograms per deciliter, with approximately 8.5 percent of the children predicted to attain blood lead levels greater than 15 micrograms per deciliter. When a soil lead/dust lead level of 1,000 ppm was substituted into the model, approximately 34 percent of the children were predicted to have blood lead levels greater than 15 micrograms per deciliter. This would put 34% of the Granite City children above a level which may represent a risk of adverse health effects. It is notable that the model shows that for most ages, the soil/dust lead intake is greater than 29 micrograms per day while the lead intakes from air and water are nonsignificant. The model also shows that the 500 ppm soil clean-up level appears to be appropriate because further reductions in food lead levels are anticipated due to the removal of lead-containing soils, to education of residents on ways to reduce lead intake in children provided by the U.S. EPA and IEPA, and to the possible impact of reductions in allowable releases of lead to the air and in the water expected from changes to the National Ambient Air Quality Standard and the National Primary Drinking Water Regulations later this year.

In conclusion, EPA Region V has set a 500 ppm lead soil clean-up level at the NL/Taracorp Superfund site. It ii the best professional judgement of the staff that this level represents the minimun soil clean-up level which can be expected to protect the most sensitive Granite City residents, children under the age of six years.

REFERENCES

ATSDR, The Nature and Extent of Lead Poisoning in Children in the United States: a Report to Congress, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta, GA, 1988.

Binder, S., D. Sokal and D. Maugham, Estimating soil ingestion: the use of tracer elements in estimating the amount of soil ingestion by young children, Arch. Environ. Health, 41: 341-345 (1986).

Calabrese, E.J., H. Pastides, R. Barnes, et al., How much soil do young children ingest: an epidemiological study, Reg. Toxical. Pharmacol., (1989)

FR 50, Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures, Federal Register 50; 1170-1178, Wednesday, January 9, 1985.

Mielke, H.W., J.L. Adams, P.L. Reagan, and P.W. Mielke, Jr., Soil-dust lead and childhood lead exposure as a function of city size and community traffic flow: the case for lead abatement in Minnesota, In B.E. Davies and B>G> Wixson, eds., Lead in Soil: Issues and Guidelines, Supplement to Environmental Geochemistry and Health, Supplement to Volume 9, 253-268 (1989).

Milar, C. and P. Mushak, "Lead contaminated housedust; hazard, measurement and decontamination", in J. Chisolm and D. O'Hara, eds., Lead Absorption in Children, Urban and Schwarzenberg, Baltimore, MD, 1982, pp 143-152.

Needleman, H.L., The persistent threat of lead: medical and sociological issues, Curr. Probl. Pediatr. 18: 697-744 (1988).

OLSC (Ontario Lead in Soil Committee), Review and Recommendations on a Lead in Soil Guideline, Report to the Ontario Minister of the Environment, ISBN 0-7729-2715-4, Hazardous Contaminants Branch, May 1987.

Remedial Investigation Report, Granite City Site, Granite City, Illinois, prepared by O'Brien & Gere Engineers, Inc., Syracuse, NY, September 1988.

Shellshear, I., L. Jordan, D. Hogan and F. Shannon, Environ-mental lead exposure in Christchurch children: soil lead as a potential hazard, New Zealand Med. J., 81: 382-386 (1975).

Steele, M.J., B.D. Beck and B.L. Murphy, Assessing the contribution from lead in mining wastes to blood lead, Gradient Corporation, Cambridge, MA, prepublication copy, 1989.

USEPA 1986a, Air Quality Criteria for Lead, EPA-600/8-83/028aF-dF, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1986.

USEPA 1989a, Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation, Final Draft. Office of Air

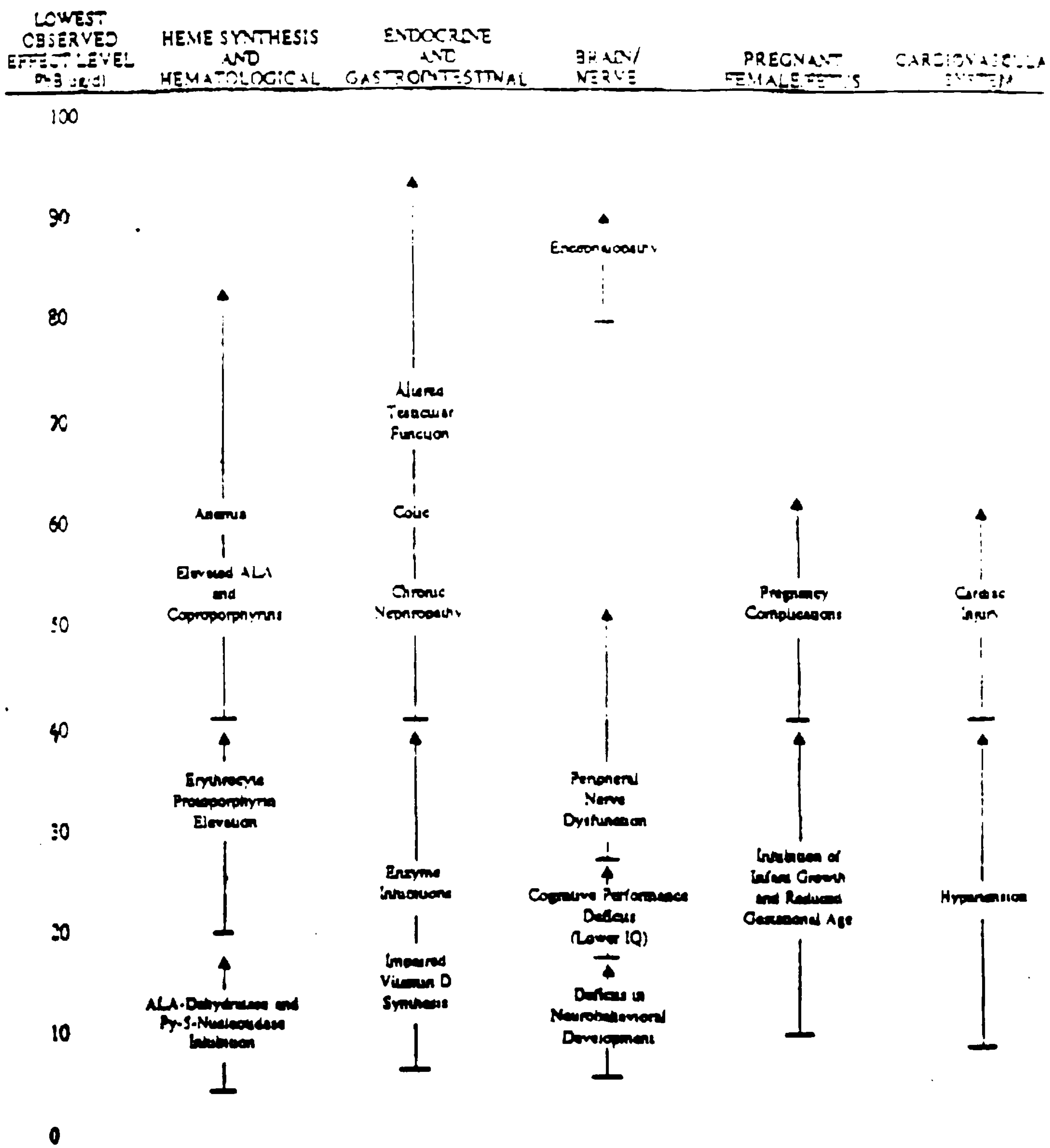
Quality Planning and Standards, Air Quality Management Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1989.

USEPA 1989b, Technical Support Document on Lead, ECAO-CIN-G7, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Cincinnati, OH, 1989.

USDHHS, Preventing Lead Poisoning in Young Children, U.S. Department of Health and Human Services (Centers for Disease Control), January 1985.

TABLE 1

Summary of Lowest Observed Effect Levels For Lead-Induced Health Effects in Children and Adults



Adapted from U.S. EPA (1986a) with modifications according to ATSDR (1988a)

TABLE 2

SUMMARY OF RECENT STUDIES ON THE ASSOCIATION OF PRENATAL LEAD EXPOSURE WITH SELECTED FETAL OUTCOMES(1)

Reference	N	PbB values Source	Average µg/dl	Gestational Age	Birth Weight
Ernhart et al. (1985a, 1986)	185	maternal del.	6.5	0	0
	162	cord	5.8	0	0
Bellinger et al. (1984)	216	cord	6.5	+	-[a]
Needleman et al. (1984)	4354	cord	6.5	0	0
Bornschein et al. (1989)	202	[illegible]	7.0	0	-*
Dietrich et al. (1989)	185	maternal pre	8.3	-*	-*
Wolf et al. (1987)	182	infant postnatal	10.3		-*
McMichael et al. (1986)	749	maternal del	11.[illegible]	-*	+
		cord	10.[illegible]	-*	+
Moore et al. (1982)	236	maternal del	14.0 g.m.	-*	0
		cord	12.0 g.m.	-*	0
Rothenberg et al. (1989)	51	maternal pre	15.0		
		maternal del	15.4	0	-*
		cord	13.8		
Graziano et al. (1989)	907	maternal (prospect.)	17.1 g.m.		0
	639	maternal (retrosp.)	15.9 g.m.	0[b]	
Ward et al. (1987)	100	placental Pb	2.35 µg/g	−	-*

Symbols: 0, no evident relationship; +, positive relationship; -, negative relationship; *, statistically significant at $p<0.05$; g.m., geometric mean.

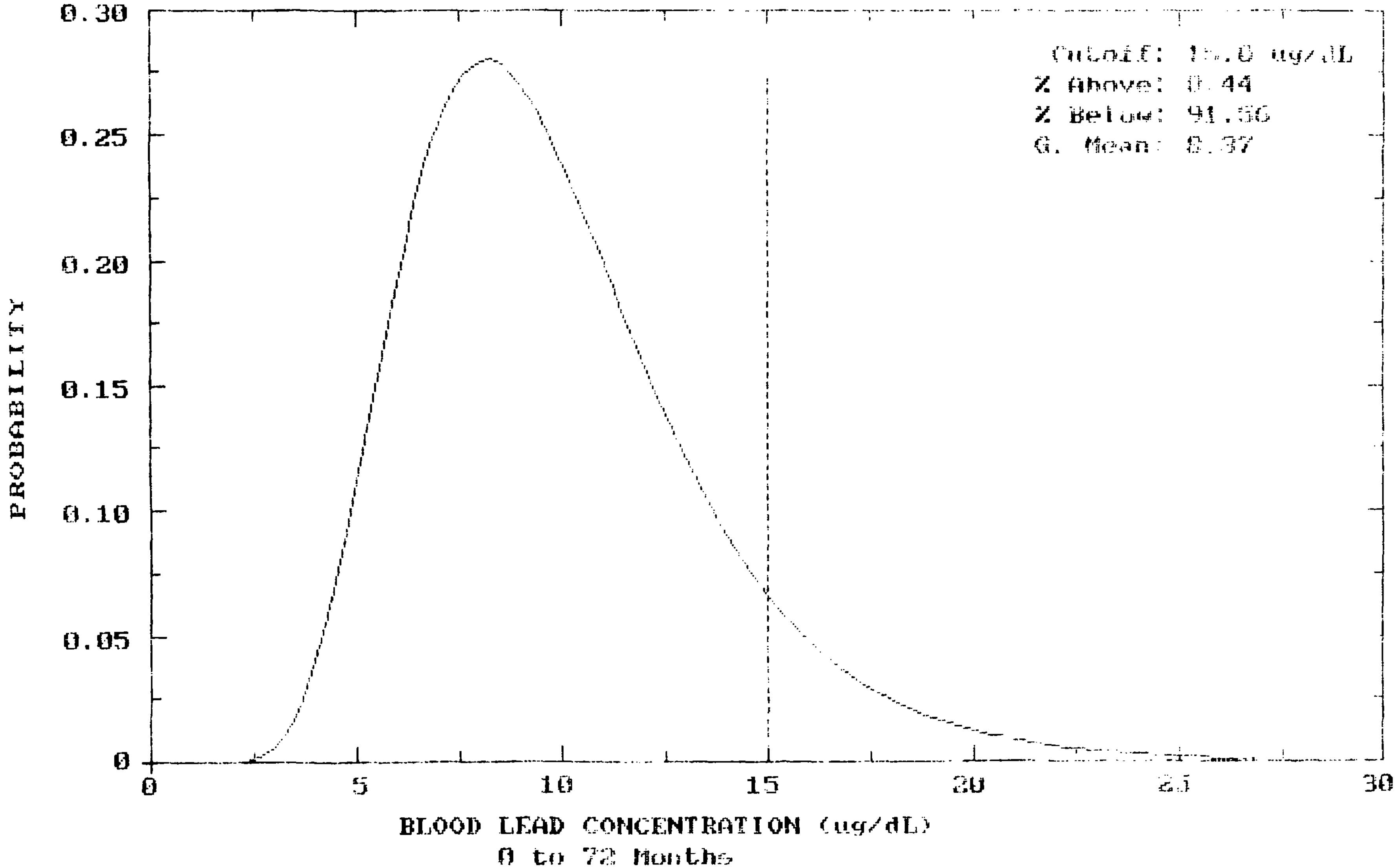
[a]Birth weight showed no relationship, but the trend in percentage of small-for-gestational-age infants was nearly statistically significant at $p<0.05$.

[b]Rate of spontaneous abortions.

(1)From: U.S. EPA 1989a.

Figure 1

Integrated Uptake/Biokinetic Model (500 ppm soil/dust Pb + NL/Taracorp site-specific data)



Air Concentration: 0.260 ug/m3

Diet: DEFAULT

Drinking Water: 8.88 ug/L DEFAULT

Soil & House Dust: Values entered by user.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	500.0	500.0
1-2	500.0	500.0
2-3	500.0	500.0
3-4	500.0	500.0
4-5	500.0	500.0
5-6	500.0	500.0
6-7	500.0	500.0

Additional Dust Sources: None DEFAULT

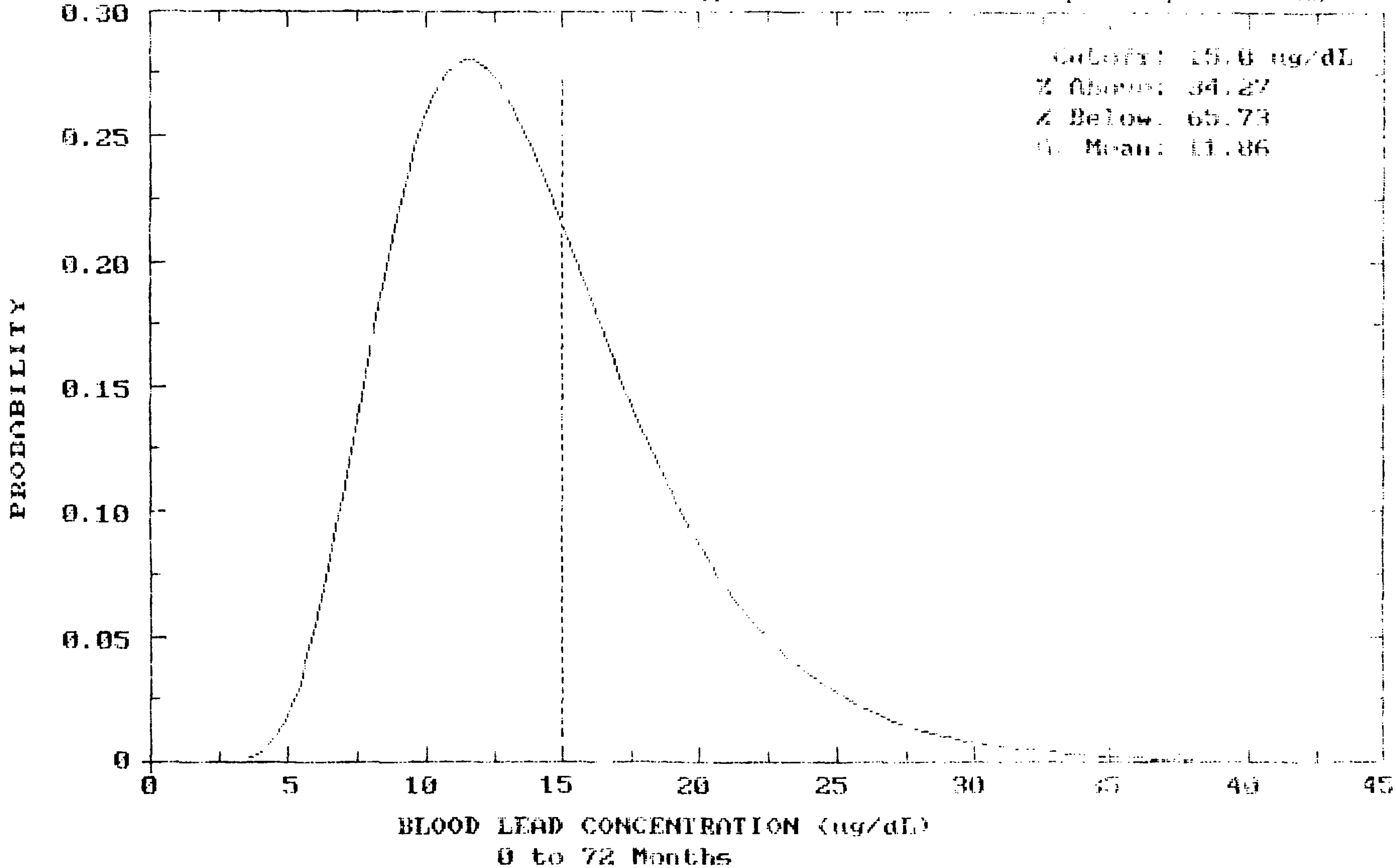
Paint Intake: 0.00 ug/day DEFAULT

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	5.13	15.73	3.75
1-2:	7.50	30.42	14.99
2-3:	8.78	32.04	14.99
3-4:	9.22	32.24	14.98
4-5:	9.66	32.54	14.97
5-6:	9.83	33.57	14.96
6-7:	10.01	35.08	14.95

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	10.93	0.89	0.00	0.16
1-2:	12.96	2.22	0.00	0.25
2-3:	14.33	2.31	0.00	0.41
3-4:	14.49	2.35	0.00	0.41
4-5:	14.71	2.44	0.00	0.41
5-6:	15.45	2.58	0.00	0.57
6-7:	16.94	2.62	0.00	0.57

Figure 2

Integrated Uptake/Biokinetic Model (1000 ppm soil/dust Pb + NL/Taracorp site-specific data)



Air Concentration: 0.260 ug/m3

Diet: DEFAULT

Drinking Water: 8.88 ug/L DEFAULT

Soil & House Dust: Values entered by user.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1000.0	1000.0
1-2	1000.0	1000.0
2-3	1000.0	1000.0
3-4	1000.0	1000.0
4-5	1000.0	1000.0
5-6	1000.0	1000.0
6-7	1000.0	1000.0

Additional Dust Sources: None DEFAULT

Paint Intake: 0.00 ug/day DEFAULT

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	6.21	19.48	7.50
1-2:	10.68	45.33	29.90
2-3:	12.88	46.88	29.83
3-4:	13.47	46.98	29.73
4-5:	14.07	47.16	29.60
5-6:	14.20	48.04	29.44
6-7:	14.27	49.38	29.24

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	10.93	0.89	0.00	0.16
1-2:	12.96	2.22	0.00	0.25
2-3:	14.33	2.31	0.00	0.41
3-4:	14.49	2.35	0.00	0.41
4-5:	14.71	2.44	0.00	0.41
5-6:	15.45	2.58	0.00	0.57
6-7:	16.94	2.62	0.00	0.57

9. VALUES of DEFAULT PARAMETERS

The values of the default parameters which can be changed by the user are as follows:

Air Data: Air Concentration: 0.20 μg Pb/m³
Lung Absorption: 31.5%
Vary Air Conc by Year: NO
Ventilation Rate
Age 0-1: 2.0 m³/day
1-2: 3.0 m³/day
2-3: 5.0 m³/day
3-4: 5.0 m³/day
4-5: 5.0 m³/day
5-6: 7.0 m³/day
6-7: 7.0 m³/day

Water Data: Water Concentration: 8.88 μg/ℓ
Use Alternate Values: NO
Water Consumption
Age 0-1: 0.20 ℓ/day
1-2: 0.50 ℓ/day
2-3: 0.52 ℓ/day
3-4: 0.53 ℓ/day
4-5: 0.55 ℓ/day
5-6: 0.58 ℓ/day
6-7: 0.59 ℓ/day

Diet Data: Use Alternate Values: NO
Diet Intake
Age 0-1: 21.86 μg Pb/day
1-2: 25.94 μg Pb/day
2-3: 28.71 μg Pb/day
3-4: 29.05 μg Pb/day
4-5: 29.53 μg Pb/day
5-6: 31.10 μg Pb/day
6-7: 34.26 μg Pb/day

Soil & Dust Data: Use Alternate Dust Values: NO
Calculate
Amount Ingested Daily
Age 0-1: 0.005 g/day
1-2: 0.050 g/day
2-3: 0.200 g/day
3-4: 0.200 g/day
4-5: 0.050 g/day
5-6: 0.050 g/day
6-7: 0.050 g/day

$\bar{X}_{0-7} = 0.056$ g/day } Use: 0.100 g/day age 9mo-7y

Paint Data: Amount Ingested Daily: 0.0 μg Pb/day (all ages)

Graph Values: GSD: 1.42
Cutoff: 10 μg Pb/dℓ